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Abstract

TWO-PHASE FLOW INVESTIGATIONS FOR A MARINE BOILING WATER REACTOR

by

E. Kjelland-Fosterud, I. Bencze,
B. Kierulf and O.R. Kolberg
Institutt for Atomenergi
Kjeller, Norway

The paper describes research work done in support of a marine nuclear reactor design project. It is important to be able to predict the dynamic behaviour of a boiling water reactor in a seaway. Since only the hydraulic circuit is affected, it is sufficient to investigate this experimentally, using the experimental results as a partial check on the validity of a mathematical dynamics model for the whole reactor.

Tests have been done in a 30 kW, 50 ata natural circulation loop which can be oscillated vertically. The stroke is 10 meters, and the accelerations are between 0.6 g and 2 g.

The momentum of the circulating water is important for the dynamic response of a boiling water reactor. A design is described which gives the designer freedom to vary the inertia of the water in the downcomer within wide limits. The effect of this design on the dynamic behaviour of the reactor is described in the paper by H. Christensen et al. The results indicate that powerful circulation pumps are unnecessary.

However, forced circulation improves the stability of a boiling water power reactor. Instead of conventional pumps it is proposed to use a combined steam injector-jet pump, which gives negligible expenses compared with conventional pumps. The injector theory will be explained, and experimental data from a loop with maximum pressure 100 ata and maximum power 300 kW will

be reviewed. The influence of the injector on the B.W.R. design and behaviour will be discussed.

In a reactor using natural circulation or injector circulation the circulation is greatly affected by carry-under of steam into the downcomer, which reduces the natural circulation driving head available. It appears that carry-under must be limited to very small values in such reactors.

Carry-under has been investigated experimentally in the mobile loop referred to above, and in large-scale air-water loops. By regarding carry-under as an aspect of a two-phase flow pattern problem, it has become clear that geometrical effects are important. These have been investigated and the results are given.